

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
13 May 2004 (13.05.2004)

PCT

(10) International Publication Number  
**WO 2004/039544 A1**

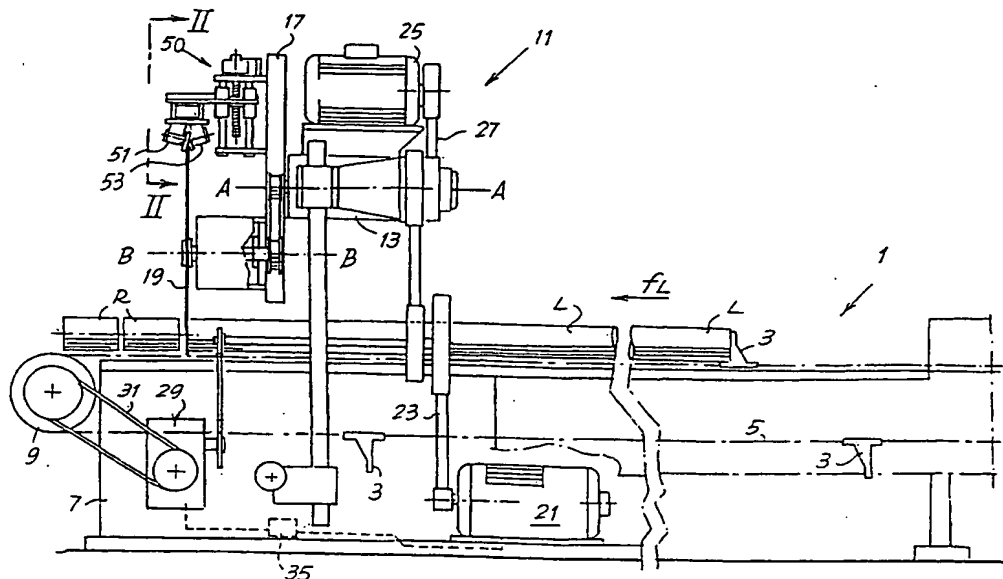
- (51) International Patent Classification<sup>7</sup>: **B26D 7/12**
- (21) International Application Number: **PCT/IT2003/000662**
- (22) International Filing Date: 27 October 2003 (27.10.2003)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
FI2002A000207 30 October 2002 (30.10.2002) IT
- (71) Applicant (for all designated States except US): **FABIO PERINI S.P.A.** [IT/IT]; Zona Ind.le P.I.P. Mugnano Sud, I-55100 Lucca (IT).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **CHIOCCHETTI, Mario, Gioni** [IT/IT]; Via del Tiglio, 612, Pieve di Compto, I-55065 Capannori, Lucca (IT). **GELLI, Mauro** [IT/IT]; Via del Marginone 24, Fraz. Pieve S. Paolo, I-55066 Capannori (IT). **RIDOLFI, Quirino, Fernando** [IT/IT]; Via di Tiglio 290, Fraz. Carraia, I-55061 Capannori (IT).
- (84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- (81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (74) Agents: **MANNUCCI, Michele et al.**; Ufficio tecn. Ing A. Manucci S.R.L., Via della Scala, 4, I-50123 Firenze (IT).

**Published:**

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: **SHARPENING UNIT AND CUTTING MACHINE COMPRISING AT LEAST ONE BLADE AND SAID SHARPENING UNIT**



(57) Abstract: The sharpening unit (50) comprises a grinding wheel unit (80) with at least two grinding wheels (51, 53) opposed to act on two sides defining a cutting bevel of the blade (19). The grinding wheel unit is provided with at least a degree of freedom to center the grinding wheels (51, 53) in respect of a lying surface of the portion of the cutting bevel of the blade (19) on which said grinding wheels act.

Sharpening unit and cutting machine comprising at least one blade and said sharpening unit

### Description

#### Technical Field

5           The present invention relates to a cutting machine for cutting elongated products, such as and in particular logs of web material for the production of small rolls destined for packaging and sale.

          More specifically, the invention relates to a cutting machine with at least a cutting blade and at least a sharpening unit associated with said cutting blade.

10           The invention also relates to a sharpening unit for cutting machines or other machines provided with a blade that must be constantly or periodically sharpened.

#### State of the Art

          In the paper converting industry rolls or logs of substantial axial length are produced by winding a predetermined quantity of paper, for example tissue paper, to  
15           subsequently produce small rolls of toilet tissue, kitchen towels and the like. For this purpose the logs are cut orthogonal to their axis and divided into a plurality of small rolls of a suitable length, which are then packaged for distribution and sale. The logs are cut by means of special "cutting" machines, which have one or more cutting blades and one or more sharpening units for each blade.

20           Analogous requirements are found in other technological sectors, where it is necessary to cut an elongated product into smaller portions, in particular logs of wound web material.

          US-A-3,213,731 describes a cutting machine for logs of web material, wherein a disk-shaped blade rotates about its axis supported by a unit in turn rotating about a  
25           principal axis parallel to the direction of feed of the logs to be cut, which are fed along a feed path towards the cutting area.

          An analogous cutting machine, but with two disk-shaped cutting blades, is described in US-RE-30,598. In this case the axis of rotation of each disk-shaped blade is parallel to the axis of the logs to be cut, but skew in respect of the principal axis of rotation  
30           of the unit carrying the blades, to obtain a component of motion of the blade in a direction parallel to the direction of feed of the logs to be cut, so that these can advance with continuous movement at constant speed. A sharpening unit with two sharpening grinding wheels for each blade periodically sharpens the respective blade that loses its cutting edge.

          EP-A-507750 describes a cutting machine wherein the rotating unit carrying the

disk-shaped blade(s) is provided with alternate translatory movement to allow the logs to be cut to move forwards with continuous movement. The feed speed of the logs is variable and not constant, to obtain a series of advantages in terms of flexibility and reduction in stresses and in the overall dimensions of the machine. In this case too a sharpening unit is  
5 provided, with two grinding wheels to restore the cutting edge of the blades

EP-A-609668 describes a cutting machine with a rotating unit carrying two disk-shaped blades rotating about respective axes parallel to the logs to be cut, but skew in respect of the axis of rotation of the rotating unit. The logs are fed at a variable speed as in EP-A-507750 to obtain the same advantages of flexibility.

10 EP-A-0555190 describes a cutting machine with a helical cutting blade and a sharpening unit with two grinding wheels.

US-A-5,038,647 describes a cutting machine that uses a band blade rather than a disk-shaped blade, particularly suitable for cutting rolls with a large diameter. Two sharpening units with different functions are associated with the blade. A first sharpening  
15 unit, with motorized grinding wheels, produces and sharpens the principal bevel of the blade, while a second unit with idle grinding wheels keeps a counter-bevel or secondary bevel sharpened.

WO-A-0136151 describes a sharpening unit for the blade of a cutting machine, with tools to dress the grinding wheels.

20 In prior art machines the grinding wheels are carried by a grinding wheel unit that is gradually moved towards the blade to be sharpened in order to offset the reduction in diameter (in the case of disk-shaped or helical blades) or in width (in the case of band blades) due to wear caused by repeated sharpening operations. The movement towards the blade is set by the operator normally as a function of the number of sharpenings performed  
25 on the blade. In other words, the grinding wheel unit is moved towards the blade by a predetermined extent after a predefined number of sharpening operations, assuming that this corresponds to a wear and thus a reduction in the dimension of the blade that are always constant. The movement towards the blade is calculated so that contact is always guaranteed with sufficient pressure of the grinding wheel on the blade, even if there should  
30 accidentally be more wear than expected. This means that there is often more pressure of the grinding wheels on the blade than necessary and consequently also excessive wear on the blade. On the contrary, there may be insufficient sharpening pressure, caused by the blade and the grinding wheels not having been moved close enough together. In this case sharpening is not performed efficaciously.

Moreover, due to the rigidity of the grinding wheel unit the pressure with which the two grinding wheels operate on the two sides of the blade is not equal, due to unavoidable errors in positioning, tolerances and any uneven wear on the grinding wheels.

Objects and summary of the invention

5 The object of the present invention is to provide a sharpening unit, in particular although not exclusively for cutting machines to cut elongated products, which allows more efficient sharpening in respect of prior art sharpening units.

Another object of the invention is to provide a cutting machine to cut products, especially although not exclusively logs of web material, comprising at least one  
10 particularly efficient sharpening unit and which on the one hand sharpens the blades accurately and on the other causes limited wear on the blade(s).

For this object, according to a first aspect of the present invention, a sharpening unit is provided comprising a grinding wheel unit with at least two opposed grinding wheels to act on two sides of a blade, characterized in that said grinding wheel unit is equipped with  
15 at least a degree of freedom to center the grinding wheels in respect of a lying surface of the portion of the cutting edge of the blade on which the grinding wheels act. This allows a balanced and uniform sharpening action on the two sides of the blade. Moreover, when the grinding wheel unit is equipped with a movement towards the blade to recover any decreases in the dimension of the blade caused by wear, with self-centering of the grinding  
20 wheels the pressure exerted can be controlled more accurately, avoiding pressures and thus excessive wear.

The blade can be a flat disk-shaped blade, in which case centering is performed in practice in respect of a lying plane of the cutting edge. However, the blade can also have other forms, for example it can extend helically with a corresponding helical form of the  
25 cutting edge. In this case centering of the two grinding wheels takes place in respect of the lying surface of the portion of cutting edge or cutting bevel of the blade on which the grinding wheels are temporarily acting and this surface can vary according to the position of the grinding wheels along the blade. In the case of band blade, the lying surface of the cutting edge, in respect of which the grinding wheels are centered, is a plane parallel to the  
30 portion of the band forming the blade on which the area of the cutting edge is found that is instantaneously sharpened.

A further aspect of the present invention relates to a cutting machine for cutting elongated products, comprising: at least one path for the products to be cut; at least one device to feed the products along said path; at least one blade provided with a cutting

movement to cut said products; at least one sharpening unit for said blade, which comprises a grinding wheel unit with at least two opposed grinding wheels to act on two sides of said blade. According to the invention, the machine is characterized in that the grinding wheel unit is provided with at least a degree of freedom to center the grinding wheels in respect of a lying surface of the portion of the cutting edge, that is of the cutting bevel of the blade on which the grinding wheels act. The grinding wheel unit can be taken to a fixed position in respect of the blade, when the dimensions of the latter vary slightly due to wear and said wear can be recovered for example by moving the grinding wheels towards the blade without also moving the grinding wheel unit. Nonetheless, the sharpening unit normally comprises a system to move the grinding wheel unit towards the blade along a direction of forward movement, to recover wear on the blade. In this case, self-centering of the grinding wheels is particularly important and advantageous as it prevents the onset of excessive sharpening pressures, or – on the contrary – conditions of insufficient pressure and thus insufficient sharpening.

According to a particular embodiment, the grinding wheel unit is provided with a further degree of freedom, partly restricted, to center the grinding wheels in respect of the blade. Partly restricted degree of freedom is intended as possible movement restricted, for example, through the effect of a return spring and/or an actuator that limits the freedom of movement of the grinding wheel unit according to this degree of freedom. For example, the grinding wheel unit is free to move in one direction, but its movement is limited in the other direction, or the movement is contrasted by a return spring. This guarantees that the movement according to this further degree of freedom always brings the grinding wheels into contact with the blade to be sharpened, preventing movement away from the cutting edge.

According to an advantageous embodiment, this second degree of limited or restricted freedom is represented by the fact that the grinding wheel unit can rotate or oscillate about an axis of oscillation. In this way the grinding wheel unit revolves about an axis of oscillation disposed generically in an intermediate position between the axes of rotation of the grinding wheels and in substance lying on the lying plane of the portion of cutting edge on which the grinding wheels acts. When the blade has a cutting edge that does not lie on the plane but on a lying surface of a different shape, such as the case of a helical blade, the axis of oscillation can lie on a plane that approximates the lying surface of said portion of cutting edge.

The grinding wheels are generally disposed with their respective axes of rotation

skew. According to a preferred embodiment of the invention, the axis of oscillation of the grinding wheel is advantageously disposed in a position of minimum distance between said axes of rotation. In practice, the axis of oscillation can also be the axis of symmetry of the grinding wheels, i.e. these are disposed in a substantially symmetrical way in respect of the axis of oscillation. The movement of the grinding wheel unit about the axis of oscillation must be restricted, so that the grinding wheels are effectively stressed to come into contact with the blade to be sharpened, rather than tending to move to a non-operating position. For this purpose an elastic return element, an actuator element or another device or means to control the pressure may be provided with which the grinding wheels are pushed against the blade. In substance, therefore, oscillation of the grinding wheel unit represents a further degree of freedom in the movement of the grinding wheel unit, although this movement is not strictly completely free, but restricted so that it takes place in the direction that brings the grinding wheels effectively into the operating position against the blade.

The axis of oscillation of the grinding wheel unit may be essentially parallel to the direction of feed of the grinding wheel unit in respect of the blade and be essentially orthogonal to the direction of feed of the products to be cut towards the blade.

According to a further particularly advantageous characteristic of a possible embodiment of the invention, the grinding wheel unit is free to translate along a direction of translation not parallel to the lying plane of the blade, to center the grinding wheel in respect of the lying plane, that is the median plane of the blade. The direction of translation is in practice essentially orthogonal to the lying plane of the blade and preferably approximately substantially parallel to the direction of feed of the products to be cut. The axis of oscillation of the grinding wheel unit is therefore advantageously orthogonal to the direction of translation of the unit. According to this preferred embodiment of the invention, therefore, the grinding wheel unit has a first degree of freedom consisting in the fact that it can translate in the direction of translation, and a second degree of freedom consisting in the fact that it can oscillate about the axis of oscillation, the latter movement being limited or restricted in the manner and for the reasons explained above.

The machine according to the invention may have one or more blades. Moreover, a single sharpening unit or even more than one sharpening units may be associated with the blade or with each blade. In this case the two or more sharpening units advantageously have different characteristics and functions. For example, a first unit can have motorized grinding wheels to sharpen the principal bevel of the blade and the second can have idle grinding wheels to sharpen the counter-bevel of the blade. The grinding wheels of the two

units can typically have different inclinations. One blade that has two sharpening units to sharpen bevel and counter-bevel (or secondary bevel) is described in US-A-5,038,647. In the case of a blade with a single sharpening unit, this may have motorized grinding wheels or idle grinding wheels, which are drawn in rotation by frictional force with the blade.

5 Further advantageous features and embodiments of the invention are set forth in the appended dependent claims, and shall be described hereunder with reference to some examples of embodiment.

#### Brief description of the drawings

10 The invention shall be better understood by following the description and the accompanying drawing, showing non-limiting practical embodiments of the invention. More specifically, in the drawing:

Figure 1 shows a schematic side view of a cutting machine for cutting rolls of web material, with a rotating unit carrying a disk-shaped blade, to which a sharpening unit according to the present invention is applied;

15 Figure 2 shows a front view and partial section of the sharpening unit in a first embodiment, according to II-II in Figures 1 and 3;

Figure 3 shows a side view and partial section according to III-III in Figure 2;

Figure 4 shows a plan view according to IV-IV in Figure 2;

Figure 5 shows a partial side view of a sharpening unit in a different embodiment;

20 Figure 6 shows a plan view according to VI-VI in Figure 5; and

Figure 7 shows a section according to VII-VII in Figure 5.

#### Detailed description of the preferred embodiments of the invention

Figure 1 schematically shows a cutting machine according to the present invention. In this case it is a cutting machine for rolls of paper or other wound web material, wherein  
25 the cut is performed by a disk-shaped blade rotating about its axis, carried by a unit in turn rotating about a principal axis of rotation, parallel or approximately parallel to the direction of feed of the rolls to be cut. Advantageously, a sharpening unit of the type shown in Figures 5 to 7 with motorized grinding wheels is applied to a machine of this type. However, a sharpening unit with idle grinding wheels, of the type shown in Figures 2 to 4,  
30 may be applied (if need be in combination with or alternatively to it). The sharpening units, which shall be described hereunder with particular reference to Figures 2 to 7, may also be applied to different machines, such as cutting machines with a helical blade or with a band blade. It must therefore be understood that the machine shown in Figure 1 must be intended purely as an example of a possible machine to which sharpening units according

to the present invention may be applied.

Moreover, the sharpening grinding wheels of the unit shown in Figures 2 to 4 may also be motorized grinding wheels and, on the contrary, the grinding wheels of the sharpening unit shown in Figures 5 to 7 may be idle grinding wheels.

5        Figure 1 schematically shows (limited to its front part) the cutting machine as a whole, indicated with 1. The machine has a feed path of the logs to be cut, indicated with L, which are pushed by pushers 3 secured to a flexible chain element or the like 5, driven about driving wheels supported by a fixed structure 7. Only one driving wheel, indicated with 9, is visible in Figure 1, while the other is at the rear end of the cutting machine, not  
10 shown. In actual fact, as known from prior art, there may be more than one flexible element 5 in parallel to feed several rows of logs L according to parallel paths.

The flexible elements 5 associated with the various parallel feed channels of the logs may be motorized separately from one another to stagger the movement of logs in each feed channel.

15        The number 11 generically indicates a cutting head that by means of a support 13 carries a rotating unit 17. The unit 17 rotates about a horizontal axis A-A parallel to the direction  $fL$  of feed of the logs L. In the example shown, a disk-shaped blade 19 is mounted on the rotating unit 17, rotating about its own axis of rotation B-B parallel to the axis A-A and to the direction of feed  $fL$  of the logs L. Two or more disk-shaped blades  
20 rotating about their axes of rotation distributed about the axis A-A may be provided on the rotating unit 17. In a per se known way the rotating unit 17 can be equipped with an alternate translatory movement parallel to the direction  $fL$ , or the blade 19 can be provided individually with this movement and in this case translate in respect of the unit 17. In either of these cases the logs may be fed with continuous rather than intermittent  
25 movement.

The number 21 indicates a motor that, by means of a belt 23, transmits rotatory motion to the rotating unit 17. A second motor 25 is positioned on the support 13 of the rotating unit 17 and, by means of a belt 27, supplies rotatory motion to a shaft that drives the rotating disk-shaped blade 19 in rotation. By means of a belt 31, a third motor 29 drives  
30 the guiding wheel 9 of the continuous flexible element 5 in rotation. As mentioned above, as several parallel channels may be provided for feed of the logs L that are cut separately to form the small rolls R, a guiding wheel 9 may be associated with each channel, with its own motor unit 29 suitably controlled as a function of the angular position of the rotating unit 17. The number 35 indicates a programmable control unit that synchronizes the

forward movement of the flexible element(s) 5 through the motor(s) 29 with the angular position of the rotating unit 17 driven in rotation by the motor 21.

A sharpening unit generically indicated with 50 is disposed on the rotating unit 17, to sharpen the blade 19. The sharpening unit 50 has two grinding wheels 51 and 53, which  
5 act on two sides of the cutting edge of the blade 19.

Figures 2 to 4 show a first embodiment of the sharpening unit 50. In this embodiment idle grinding wheels are used, which are drawn in rotation through the effect of the frictional force exerted during contact between each grinding wheel and the blade 19. The sharpening unit 50 has a pair of plates 55, 57 secured to the rotating unit 17 (or to  
10 another part of the cutting machine if this does not have a rotating unit, for example to the supporting frame of a band blade). Between the two plates 55, 57 bars 59 with a circular section extend to form sliding guides for the same number of bushings 61. The bushings are integral with a carriage indicated as a whole with 63.

The carriage 63 moves along the guides formed by the bars 59 according to the  
15 arrow f63 to move gradually against the axis B-B of the blade 19, in order to hold the grinding wheels in the operating position offsetting the decrease in dimension of the blade 19 due to wear caused by sharpening.

Movement of the carriage 63 according to the arrow f63 is controlled by a free wheel mechanism 65 keyed on a threaded bar 67 parallel to the guide bars 59. A nut screw  
20 69 integral with the carriage 63 engages with the threaded bar 67. Rotation of the free wheel mechanism 65 is controlled by a piston-cylinder actuator 71 with a short stroke that acts on a bracket 73 integral with the free wheel mechanism 65. The number 75 indicates a return spring of the bracket 73. Each stroke to extend the actuator 71 causes the threaded bar 67 to rotate by an angular step and therefore a forward movement by a controlled  
25 extent in the direction of the arrow f63 of the carriage 63.

A cantilevered bracket 77 is integral with the carriage 63 and supports a pair of guides 79 essentially parallel to the axis B-B of the blade 19 and essentially orthogonal to the direction f63 of translation of the carriage 63. A slide 81 that supports a grinding wheel unit 80 is free to translate along the guides 79. A shaft 85 is supported idle by bearings 83  
30 inside the slide (see in particular Figure 2). The shaft 85 is free to rotate about its axis C-C, parallel to the axis of the threaded bar 67 and therefore to the direction f63 in which the carriage 63 and the sharpening grinding wheels move against the blade 19.

Fixed to the bottom of the shaft 85 is a plate 87 that carries integrally secured to it two blocks 89 supporting the grinding wheels 51, 53. As shown in particular in Figure 3

for the grinding wheel 53, the grinding wheels are carried by spindles 91 supported idle by bearings 93 in the blocks 89. Rotation of the grinding wheels is produced by the frictional force between them and the sides of the blade 19.

While the plate 81 is completely free to translate along a direction of translation according to the double arrow f81 parallel to the guides 79, the plate 87 carried by the shaft 85 is elastically stressed in a predetermined angular position (defined by a stop schematically indicated in Figure 2 with 88) by a pulling spring 95, the ends of which are fixed on one side to the plate 87 and on the other to a suitable point of the slide 81 (for example in the point 90 indicated in Figure 3). Alternatively, the spring 95 could be fastened to a fixed point in respect of the bracket 77. Coupling to the slide 87 is preferable as in this case the stress of the spring does not tend to produce flexure of the blade.

With this arrangement the grinding wheel unit 80 is provided with a degree of freedom along the direction of translation f81 and with a degree of freedom (limited by the presence of the pulling springs 95) constituted by the fact that the plate 87 can rotate. The grinding wheels 51, 53 integral with the grinding wheel unit 80 are thus provided with a double movement that allows them to be centered in respect of the lying plane of the blade 19, that is the median plane of the blade, or in any case the lying plane of the cutting bevel. The first movement is a movement according to the guides 79 in a direction orthogonal to the lying plane of the blade and, therefore, in the layout of the machine in Figure 1, parallel to the direction fL of feed of the products L to be cut. The second movement is an oscillatory movement about the axis C-C orthogonal to the axis B-B of the blade, and therefore to the direction of feed of the products. As can be seen in particular in Figures 2 and 3, the axis C-C lies on the median plane of the blade, or more generically on the lying plane of the cutting edge of the blade, in an intermediate position between the two grinding wheels 51, 53. More specifically, the axis C-C is in a barycentric position in respect of the axes A1-A1 and A2, A2 of the two grinding wheels 51, 53.

Thanks to this arrangement the grinding wheels can be centered on the blade 19 and the pressure they exert on the blade can be controlled to prevent excessive pressure. In fact, when the grinding wheel unit 80 is moved, through the action of the free wheel mechanism 65, according to the arrow f63, towards the axis B-B of the blade 19 by a predetermined extent, the grinding wheels 51, 53 react against the blade 19 which wedges in the space between the grinding wheels. Being free to translate with the slide 81 and the plate 87 along the guides 79 according to the arrow f81, this movement takes the grinding wheels 51, 53 to a position that is centered at all times in respect of the centerline plane of the

blade. At the same time, the fact that the grinding wheel unit can rotate the grinding wheels 51, 53 about the axis C-C means that the two grinding wheels exert on the blade the same pressure, determined by the force of the pulling spring 95.

5 As the draw spring 95 extends by a very short extent as a result of the modest oscillations of the grinding wheels about the axis C-C, it may be considered that its traction force is essentially constant and therefore the pressure exerted by the grinding wheels on the blade will also be essentially constant, irrespective of extent of the angle of oscillation about the axis C-C. Therefore, by setting a forward movement step along the direction f63 approximate to the radial wear of the blade 19, even if the effective wear of the blade is  
10 less than estimated, thanks to the fact that the grinding wheels 51, 53 can be centered in respect of the blade and to the presence of the pulling spring 95, essentially the same contact force can always be obtained between the grinding wheels and the blade and consequently the pressure strictly necessary to obtain sharpening is not exceeded, thus reducing wear on the blade and increasing its duration.

15 Instead of a spring 95 another system may be used to apply controlled stress to the plate 87 and to the grinding wheels 51, 53 about the axis C-C, for example a piston-cylinder actuator with a device to control stress.

Moreover, a position sensor may also be provided to detect the angular position of the plate 87 and of the grinding wheels 51, 53 to control forward movement of the grinding  
20 wheel unit 80 as a function of the wear on the blade. In fact, as the blade becomes worn and its diameter decreases, if the carriage 63 with the grinding wheel unit 80 does not move forward along the direction f63, the decrease in diameter is offset with rotation of the plate 87 and therefore of the grinding wheels 51, 53 about the axis C-C. Offset can be obtained up to a certain point, beyond which the plate 87 meets the stop 88. By detecting  
25 the angular position of the plate 87 the carriage 63 can be moved forward by a predeterminable extent when the plate 87 has reached a predetermined angular position, to recover wear on the blade by forward movement of the carriage.

As in the example shown the unit 17 moves with an alternate translatory movement parallel to the axis A-A of rotation to allow continuous feed of the products L to be cut, in  
30 order to prevent the onset of inertial forces on the grinding-wheel unit 80 and on the slide 81 carrying it, which would tend to make the unit translate along the guides 79, a counterweight can be secured to the slide 81 and restricted to move along the direction of the guides in the opposite direction to the direction in which the grinding-wheel unit 80 and the slide 81 move. This arrangement is indicated with a dashed line and schematically

in Figure 3. The counterweight is indicated with 101. It is guided along guides parallel to the guides 79 and not shown and linked by a pinion 103 to a rack 105 integral with the slide 81. The pinion, supported idle about a fixed axis in respect of the structure 77, also meshes with a rack not shown integral with the counterweight 101. In this way the inertial forces applied simultaneously to the counterweight 101 and to the assembly comprising the grinding wheel unit 80 and the slide 81 cause no translation of these elements along the direction f81.

Moreover, to prevent accelerations deriving from the alternate movement of the unit 17 from producing a torque on the grinding wheel unit 80 that tends to make the unit and therefore the grinding wheels 51 53 rotate about the axis C-C, the grinding wheel unit 80 is dimensioned and balanced so that its center of gravity falls on the axis C-C, or at least so that the center of gravity of the elements free to rotate about this axis, namely the shaft 85, the blocks 89, the plate 87 and the grinding wheels 51, 53, falls on it.

The device described with reference to Figures 2 to 4 is particularly suitable to produce a counter-bevel on the blade 19 or the like, for example a band blade. In this case the sharpening unit in question will be associated with another sharpening unit that produces the principal bevel.

This further sharpening unit may be produced in the same way as described, or as shown in the example of embodiment in Figures 5 to 7. This further embodiment may be also adopted to produce a single sharpening unit to sharpen blades without a counter-bevel.

Figures 5 to 7 do not show the system to move the grinding wheels towards the blade, which may be produced as in the previous example. Equivalent numbers increased by 200 indicate equivalent or corresponding parts to those in the previous example of embodiment. The number 277 indicates the cantilevered bracket that supports the slide 281 carrying the grinding wheel unit 280. The slide 281 carrying the grinding wheel unit 280 translates freely along guides 279 orthogonal to the lying plane of the blade, indicated once more with 19, and therefore parallel to its axis of rotation B-B. The slide 281 supports rotatingly about the axis C-C the shaft of the grinding wheel unit 280 on which a plate 287 is fixed, integral with which are blocks 289 carrying the grinding wheels indicated with 251 and 253. In this case the grinding wheels are motorized and the number 254 indicates the respective motors that can be, in a per se known way, pneumatic motors or the like. The axis C-C is again on the lying plane of the cutting edge of the blade and in a central position in respect of the axes A1-A1 and A2-A2 of the two grinding wheels 251, 253.

Other elements common to the previous example of embodiment such as the

moving counterweight, are not shown but may be present.

When the grinding wheels 251, 253 are pressed against the blade 19, for example by a forward movement according to the arrow f63, the oscillations of the blade can stress the grinding wheels 251, 253 making them oscillate about the axis C-C moving them away from the blade. This may occur due to the considerable flexural deformations to which the blade 19 may be subjected. This would cause vibrations and defects in sharpening.

In order to prevent this drawback, a device, indicated as a whole with 350 and described hereunder, is associated with the grinding wheel unit 280.

The device 350 comprises a slider 351 housed in a support 353 made integral (for example through a bracket not shown for clarity of the drawing) with the slide 281. The back end of the slider 351 is secured by means of a bracket 355 to a piston-cylinder actuator 357, in turn secured to the support 353. Extension and retraction of the piston-cylinder actuator 357 causes rotation of the slider 351 about its axis D-D. The slider 351 has a front rod 351A that cooperates with an appendix 359 integral with the plate 287.

The slider 351 has a channel 361 (see in particular Figure 7) that extends along a short arc of helix coaxial with the axis D-D of the slider 351. A roller 363 carried by a spindle 365 integral with the support 353 engages in the channel 361. The channel 361 and the roller 363 form a cam mechanism that obliges the slider 351 to move along the axis D-D when the actuator 357 causes a rotation of the slider about said axis. An axial thrust on the slider 351 does not cause an axial movement due to inclination of the channel 361, chosen so that the mechanism is irreversible.

In this way, when the grinding wheels 251, 253 are required to operate, they are first moved against or towards the blade 19 by the forward movement device not shown that produces a movement according to f63. The blade 19 is inserted into the space between the grinding wheels 251, 253.

In this position the grinding wheels may not be in contact with the blade 19. They are pushed and forced into the operating position with the required pressure against the sides of the blade 19 by extension of the piston-cylinder actuator 357 that brings the slider 351 into a predetermined position corresponding to an angular position of the plate 287 and of the blocks 289 and therefore of the grinding wheels 351, 353 in respect of the axis C-C. This position is maintained even if flexural deformations of the blade 19 exert an axial force on the cursor 351, thanks to the irreversibility of the cam mechanism 361, 363. The movement of oscillation about the axis C-C produced by extension of the actuator 357 produces translation of the slide 281 along the direction f281 to bring the axis C-C to the

lying plane, i.e. to the centerline of the blade 19. Therefore, also in this case the grinding wheels system is self-centering in respect of the blade.

5 The grinding wheels remain locked in their angular position in respect of the axis C-C to press with the due pressure against the blade 19 until the actuator 357 is operated again in the opposite direction to allow oscillation of the grinding wheels about the axis C-  
C and move them away from the sides of the blade 19, bringing them finally to a non-operating position. Oscillation can be controlled by a return spring, not shown.

10 The embodiment in Figures 5 to 7 therefore, allows both self-centering of the grinding wheels and movement of the grinding wheels alternately to an operating position and to a non-operating position.

This second example of embodiment may also be provided with systems, analogous to those described with reference to Figures 2 to 5, to prevent the effect of inertia on the grinding wheels.

15 It is understood that the drawing merely shows practical embodiments of the invention, which may vary in shapes and arrangements without however departing from the scope of the concept on which the invention is based. Any reference numbers in the appended claims are provided purely to facilitate their reading with reference to the description hereinbefore and the appended drawings, and do not limit the scope of protection whatsoever.

### Claims

1. A sharpening unit (50) for a blade (19), comprising a grinding wheel unit (80; 280) with at least two grinding wheels (51, 53; 251, 253) opposed to act on two sides defining a cutting bevel of said blade (19), characterized in that said grinding wheel unit is  
5 provided with at least a first degree of freedom to center the grinding wheels (51, 53; 251, 253) in respect of a lying surface of a portion of the cutting bevel of the blade (19) on which said grinding wheels act.

2. Sharpening unit as claimed in claim 1, characterized in that it comprises a system (65, 67, 69) to move the grinding wheel unit towards the blade along the direction  
10 (f63) of forward movement.

3. Sharpening unit as claimed in claim 1 or 2, characterized in that said grinding wheel unit is provided with a second degree of freedom, partly restricted, to center said grinding wheels in respect of said lying surface.

4. Sharpening unit as claimed in claim 3, characterized in that said grinding wheel  
15 unit can oscillate about an axis of oscillation (C-C) disposed in an intermediate position between the axes of rotation (A1-A1, A2-A2) of the grinding wheels (51, 53; 251, 253), the possibility to move about said axis of oscillation constituting said second degree of freedom.

5. Sharpening unit as claimed in claim 4, characterized in that said axis of  
20 oscillation (C-C) lies essentially on a lying plane of the portion of the cutting bevel of the blade on which said grinding wheels act, or on a plane that approximates a lying surface of said portion of cutting bevel of the blade.

6. Sharpening unit as claimed in at least claims 2 and 4, characterized in that said direction of forward movement (f63) of the grinding wheel unit is parallel to the axis of  
25 oscillation (C-C) of the grinding wheel unit (80; 280).

7. Sharpening unit as claimed in claim 4, 5 or 6, characterized in that said grinding wheels (51, 53; 251, 253) are disposed in an essentially symmetrical way in respect of said axis of oscillation (C-C).

8. Sharpening unit as claimed in one or more of the previous claims,  
30 characterized in that said grinding wheel unit (80; 280) is free to translate along a direction of translation (f81; f281) not parallel to the lying surface of the portion of cutting bevel on which said grinding wheels act, the movement along said direction of translation constituting said first degree of freedom.

9. Sharpening unit as claimed in claim 8, characterized in that said direction of

translation is essentially approximately orthogonal to said lying surface.

10. Sharpening unit as claimed in at least claims 4 and 8 or 4 and 9, characterized in that said axis of oscillation (C-C) is orthogonal to the direction of translation (f81; f281) of the grinding wheel unit.

5 11. Sharpening unit as claimed in at least claim 4, characterized in that the center of gravity of said grinding wheel unit (80; 280) lies on said axis of oscillation (C-C).

12. Sharpening unit as claimed in at least claim 8, characterized in that a counterweight moving along said direction of translation (f81; f281) is associated with said grinding wheel unit (80; 280), linking means (103) being provided to force the  
10 counterweight to move in the opposite direction to said grinding wheel unit along said direction.

13. Sharpening unit as claimed in at least claim 4, characterized in that said grinding wheel unit is stressed in a predetermined angular position in respect of said axis of oscillation (C-C).

15 14. Sharpening unit as claimed in one or more of the previous claims, characterized in that it comprises means to bring said grinding wheels alternately into an operating position and into a non-operating position.

15 15. Sharpening unit as claimed in at least claims 3, 8 and 14, characterized in that said means comprise an actuator (357) that produces a movement of oscillation of the  
20 grinding wheel unit (281) around said axis of oscillation (C-C) to move the grinding wheels (251, 253) against the blade in said operating position and hold them in contact with it, and in that said grinding wheel unit (281) is free to translate along said direction of translation (f281) to become centered in respect of the blade.

25 16. Sharpening unit as claimed in claim 15, characterized in that a control element (351-365) operated by said actuator is associated with said grinding wheel unit, to act on the grinding wheel unit to move the grinding wheels against the blade and bring them into an operating position, said control element being irreversible, the stress exerted by the blade on the grinding wheels not producing the opposite movement to the movement to bring the grinding wheel against the blade.

30 17. Sharpening unit as claimed in claim 16, characterized in that said control element comprises a slider (351) rotating around its axis (D-D) controlled by said actuator, and a mechanism (361, 363, 365) that produces axial sliding of said slider in a support (351) when said slider is made to rotate around its axis by said actuator, axial sliding of the slider producing rotation of the grinding wheel unit in the direction to move the grinding

wheels (251, 253) against the blade (19).

18. Sharpening unit as claimed in at least claims 4 and 7, characterized in that said grinding wheel unit (80; 280) comprises a plate (87; 287) rotatably supported around said axis of oscillation (C-C) by a slide (81; 281) sliding along a sliding guide (79) parallel to said direction of translation (f81; f281).

19. Sharpening unit as claimed in at least claims 2 and 18, characterized in that said sliding guide is carried by a carriage (63) moving along said direction of forward movement (f63) of the grinding wheel unit (80; 280).

20. Sharpening unit as claimed in at least claim 4, characterized in that it comprises an angular position sensor of the grinding wheel unit in respect of said angle of oscillation (C-C).

21. A cutting machine for cutting elongated products, comprising: at least a path for the products to be cut (L); at least a device (3, 5) to feed the products along said path; at least a blade (19) provided with a cutting movement to cut said products; at least a sharpening unit (50) for said blade, which comprises a grinding wheel unit (80; 280) with at least two grinding wheels (51, 53; 251, 253) opposed to act on said blade (19), characterized in that said sharpening unit is made according to one or more of the previous claims.

22. Cutting machine as claimed in claim 21, characterized in that said grinding wheel unit is oscillating around an axis of oscillation (C-C) essentially orthogonal to the direction of feed of the products to be cut along said path.

23. Cutting machine as claimed in claim 21 or 22, characterized in that said grinding wheel unit (80; 280) is free to translate along a direction of translation (f81) essentially parallel to the direction of feed (fL) of the products to be cut (L).

24. Cutting machine as claimed in at least one or more of claims 21 to 23, characterized in that said at least one blade (19) is a disk-shaped blade rotating around a respective axis (B-B), carried by a unit (17) rotating around its axis of rotation (A-A).

25. Cutting machine as claimed in claim 24, characterized in that said at least one disk-shaped rotating blade (19) is provided with an alternate movement essentially parallel to the direction of feed of the products to be cut and in that a counterweight (101) is associated with said grinding wheel unit (80; 280) moving along said direction of translation, connection means (103) being provided to force the counterweight to move in the opposite direction to said grinding wheel unit along said direction.

26. Cutting machine as claimed in one or more of claims 21 to 25, characterized in

that two sharpening units are associated with said at least one blade.

27. Cutting machine as claimed in claim 26, characterized in that a first sharpening unit has idle grinding wheels and a second sharpening unit has motorized grinding wheels, the grinding wheels of the first unit and the grinding wheels of the second unit having

5 different inclinations in respect of said blade.

Fig. 1

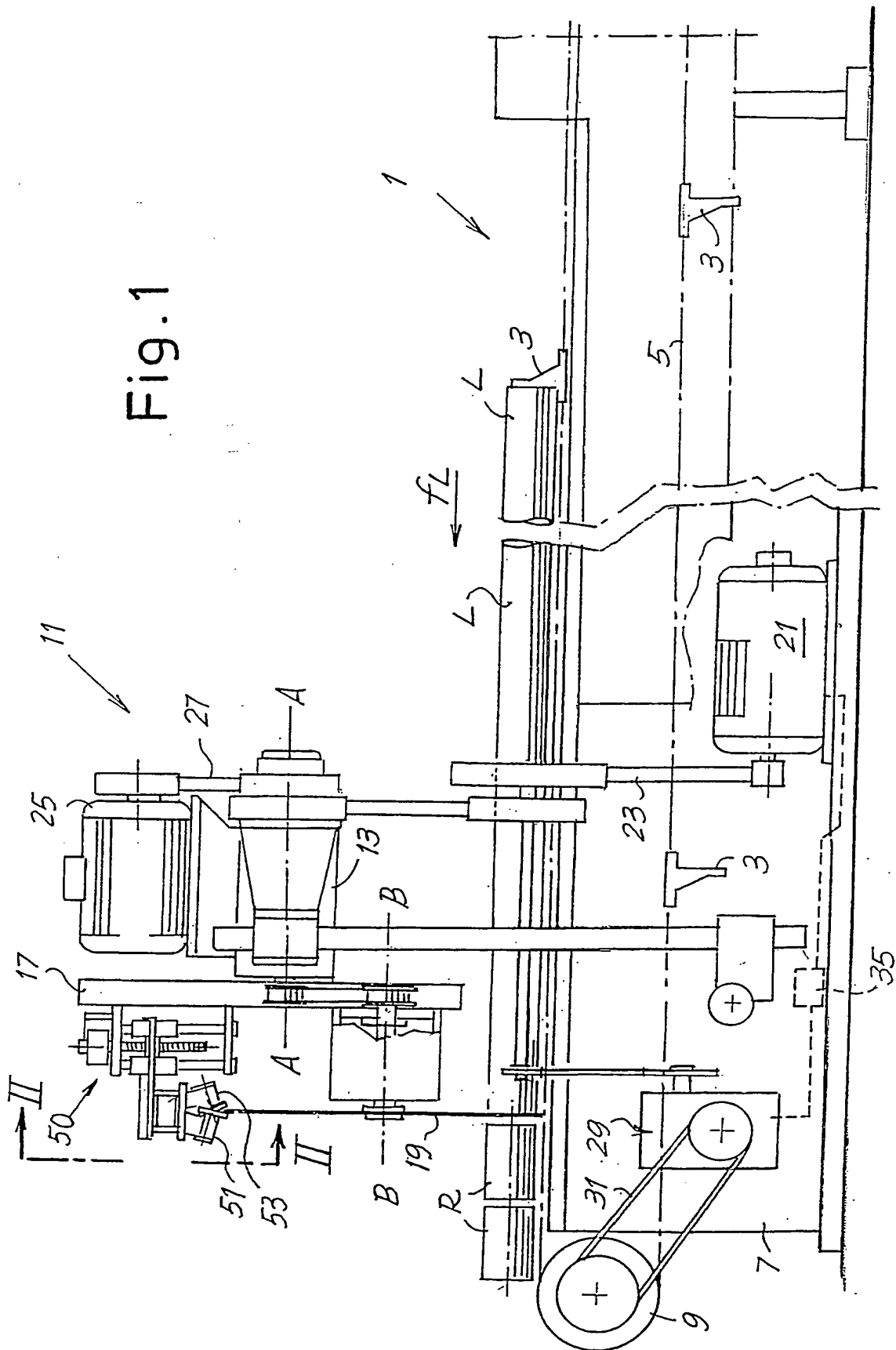
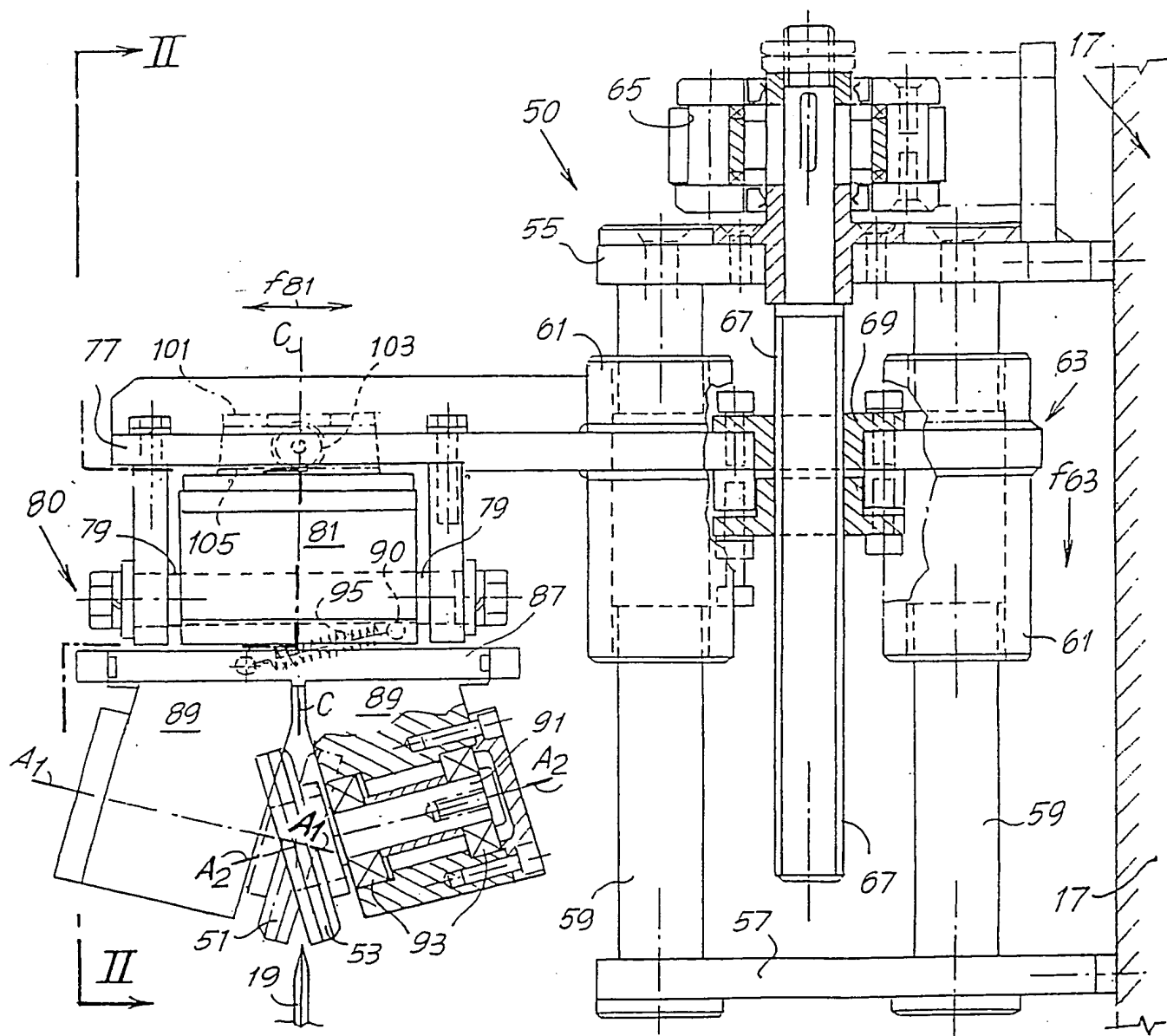




Fig. 3





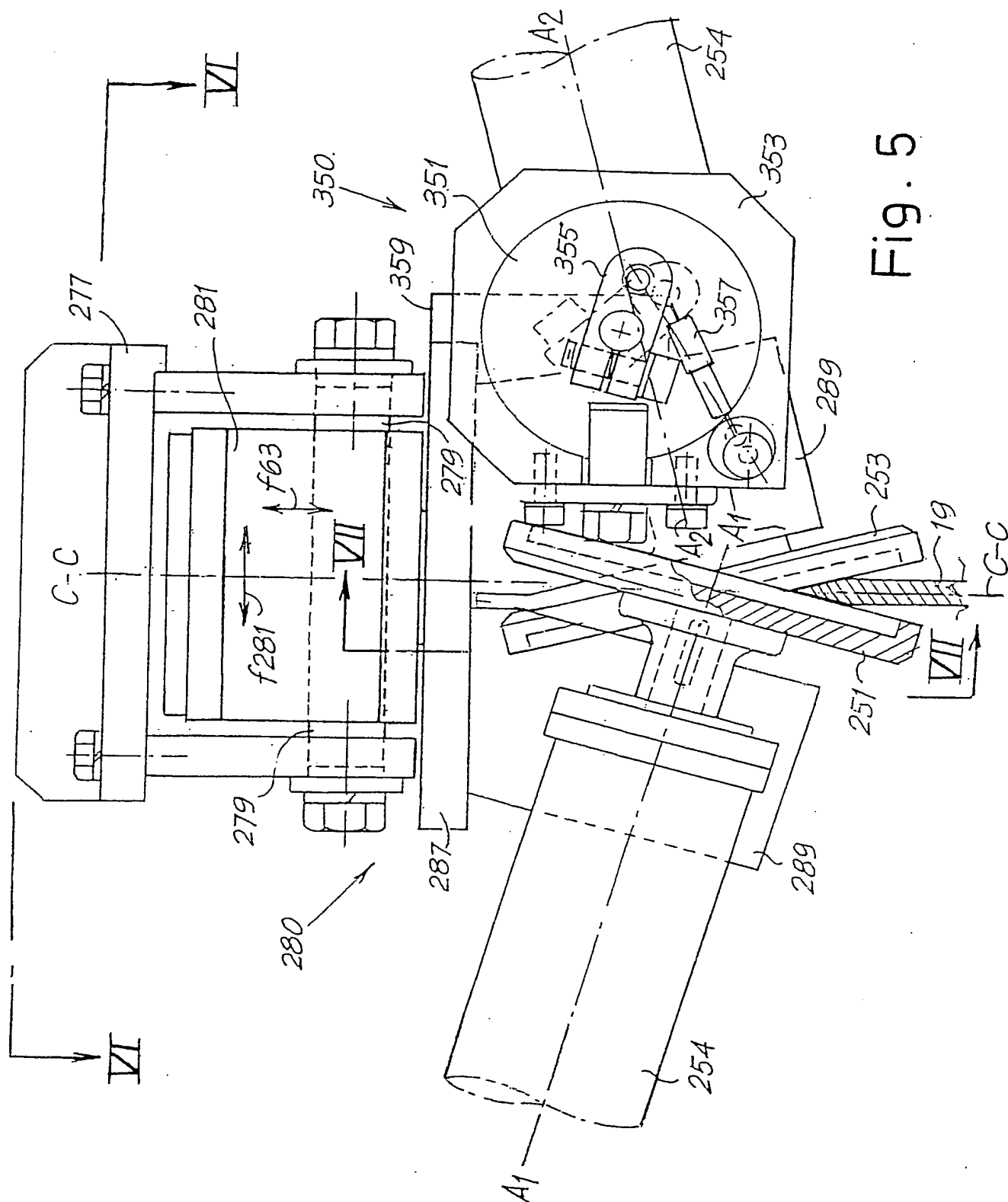
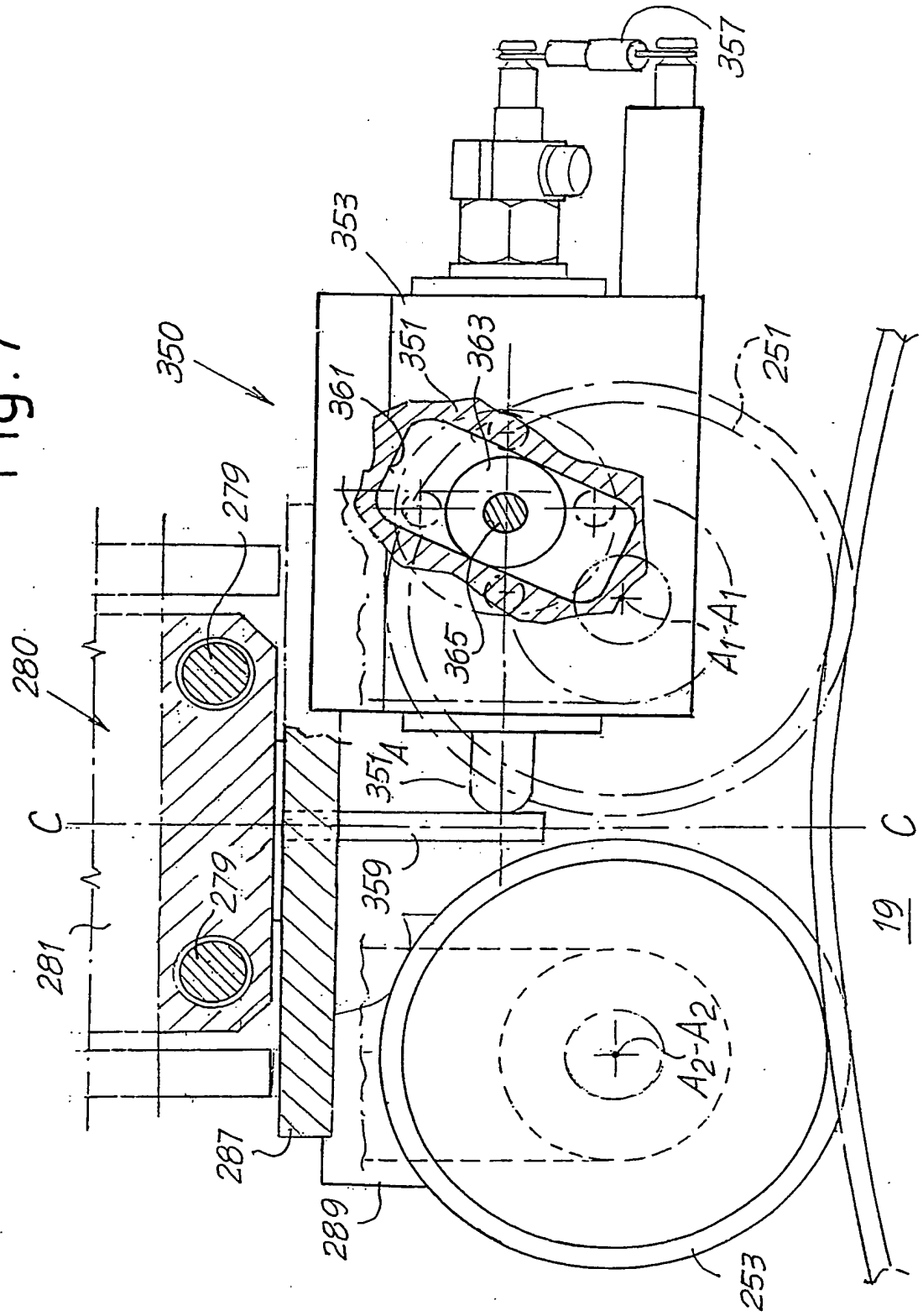


Fig. 5

Fig. 6

Fig. 7



## INTERNATIONAL SEARCH REPORT

Internal Application No

PCT/IT 03/00662

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 B26D7/12

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 B26D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 585 927 A (MITSUBISHI HEAVY IND LTD) 9 March 1994 (1994-03-09) figure 2a	1-3, 8, 9, 14
X	EP 0 528 122 A (PAPER CONVERTING MACHINE CO) 24 February 1993 (1993-02-24)	1, 2, 14, 21, 22, 24, 27
A	column 4, line 10 - column 6, line 32	4-8, 11, 13
A	EP 0 555 190 A (PERINI FABIO SPA) 11 August 1993 (1993-08-11) cited in the application	

☐ Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

## \* Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \* & \* document member of the same patent family

Date of the actual completion of the international search

17 February 2004

Date of mailing of the international search report

24/02/2004

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Rabolini, M

## INTERNATIONAL SEARCH REPORT

Information on patent family members

Internat

pplication No

PCT/IT 03/00662

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 0585927	A	09-03-1994	JP 3100240 B2	16-10-2000
			JP 6079688 A	22-03-1994
			AU 660231 B2	15-06-1995
			AU 4601793 A	10-03-1994
			DE 69310640 D1	19-06-1997
			DE 69310640 T2	20-11-1997
			EP 0585927 A2	09-03-1994
			US 5435217 A	25-07-1995
EP 0528122	A	24-02-1993	US 5152203 A	06-10-1992
			DE 69203550 D1	24-08-1995
			DE 69203550 T2	11-01-1996
			EP 0528122 A1	24-02-1993
			JP 2588463 B2	05-03-1997
			JP 6055335 A	01-03-1994
EP 0555190	A	11-08-1993	IT 1258171 B	20-02-1996
			BR 9300499 A	10-08-1993
			CA 2088881 A1	08-08-1993
			EP 0555190 A2	11-08-1993
			JP 5337882 A	21-12-1993